Eaton Wireless Sensor Network for Advanced Energy Management Solutions

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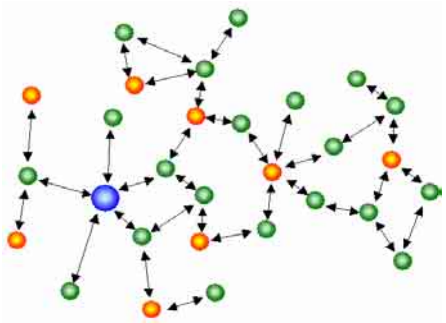
Outline

Eaton Wireless Sensor Network for Advanced Energy Management Solutions

Objectives

The Eaton Wireless Sensor Network team will research, test, develop and deploy a Wireless Sensor Network (WSN) for the purpose of enabling significant energy savings and Advancing Energy Management Solutions in the Industries of the Future (IoF).

The WSN will support open wireless protocols and be self-configuring, robust and secure in industrial environments.



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Project Summary

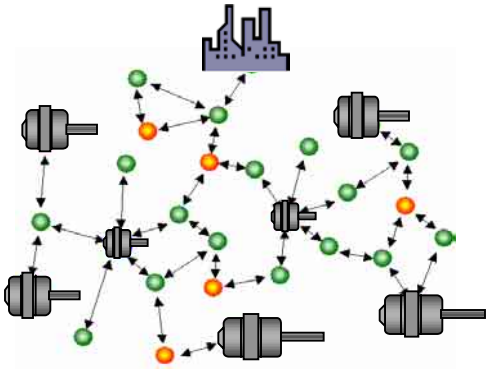
Eaton Wireless Sensor Network for Advanced Energy Management Solutions (CPS# 14225)

Goal: Enable significant energy savings for Advanced Energy Management Solutions (AEMS) in the Industries of the Future (IoF).

Challenge: Creation of an open architecture, low-cost, robust, self-configuring wireless network that will gather relevant data in the industrial environment for the IoF.

Benefits: The wireless-enabled power management system is broadly applicable to all 8 IoF. Deploying WSN to the electrical distribution and power control system enables quantifiable energy savings. Estimated energy savings greater than 279 trillion Btu/year in 2020 for targeted IoF.

FY05 Activities: This phase will extend the baseline by addressing four issues critical to fielding a robust wireless industrial network: Ultra low-power sensors/Power harvesting, Security, RF transmission in industrial environments, and Power-Aware routing.



Participants:

EATON Innovation Center

EATON Electrical

Georgia Institute of Technology

Weyerhaeuser

bp

International Paper

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Barrier-Pathway Approach

Eaton Wireless Sensor Network for Advanced Energy Management Solutions (CPS# 14225)

Barriers

- Cost of networking the equipment using conventional field signal wiring across the Industries of the Future.
- Lack of robust, secure, and cost-effective communication networks to enable collection of critical monitoring and diagnostic information in energy management solutions.
- Lack of well-written standards that promote interoperability.

Pathways

- Development of robust, self-configuring wireless sensor networks for advanced energy management solutions.
- Advanced modeling to develop and design energy management systems using distributed data.
- Eaton's positioning as thought leaders and industry drivers through IEEE802, IEEE1451, WINA and the ZigBee Alliance.

Critical Metrics

- 80% cost saving in the deployment of wireless vs. wired sensors.
- 11% to 18% energy reduction in industrial motor energy consumption by 2020.
- Creation/Adoption/Development of Wireless Industrial Communications Standard

Benefits (est.)	2020
Energy Savings	>279 trillion Btu
Cost Savings	$1300 millions
Pollutant Reduction	116 Million lbs

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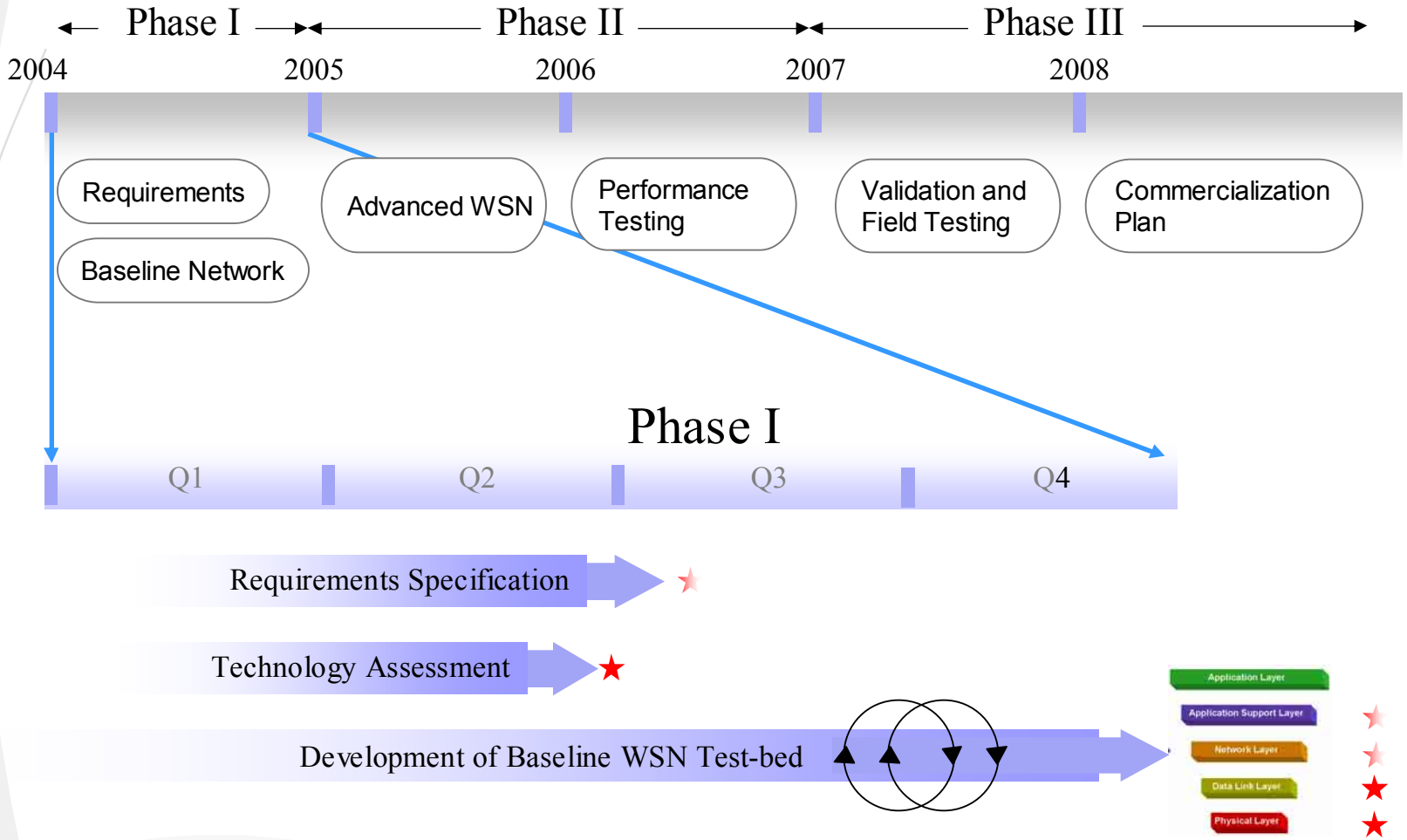
Project Status



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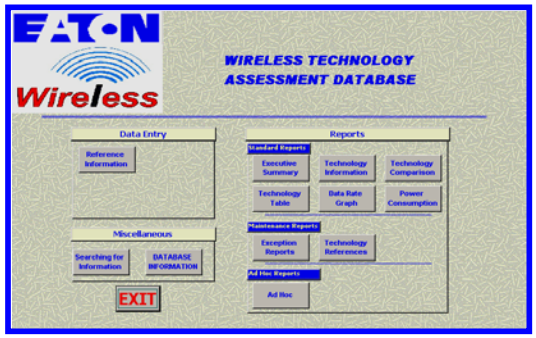
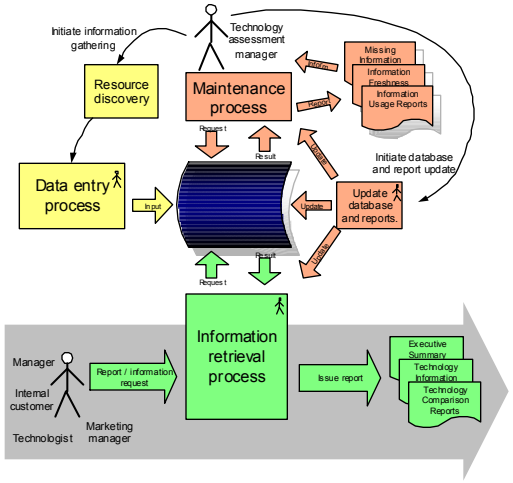
Technology Assessment

Relevance: Enable quick assessment to the current state of wireless technologies.

Approach: Centralized database of compiled information on wireless technologies, facilitating ongoing assessment of new information as soon as it becomes available.





Task Progress: First Release Completed

– Developed and deployed technology assessment process.
– Completed assessment of wireless technologies using the tool.
– Generated summary report for the phase of technology selection.

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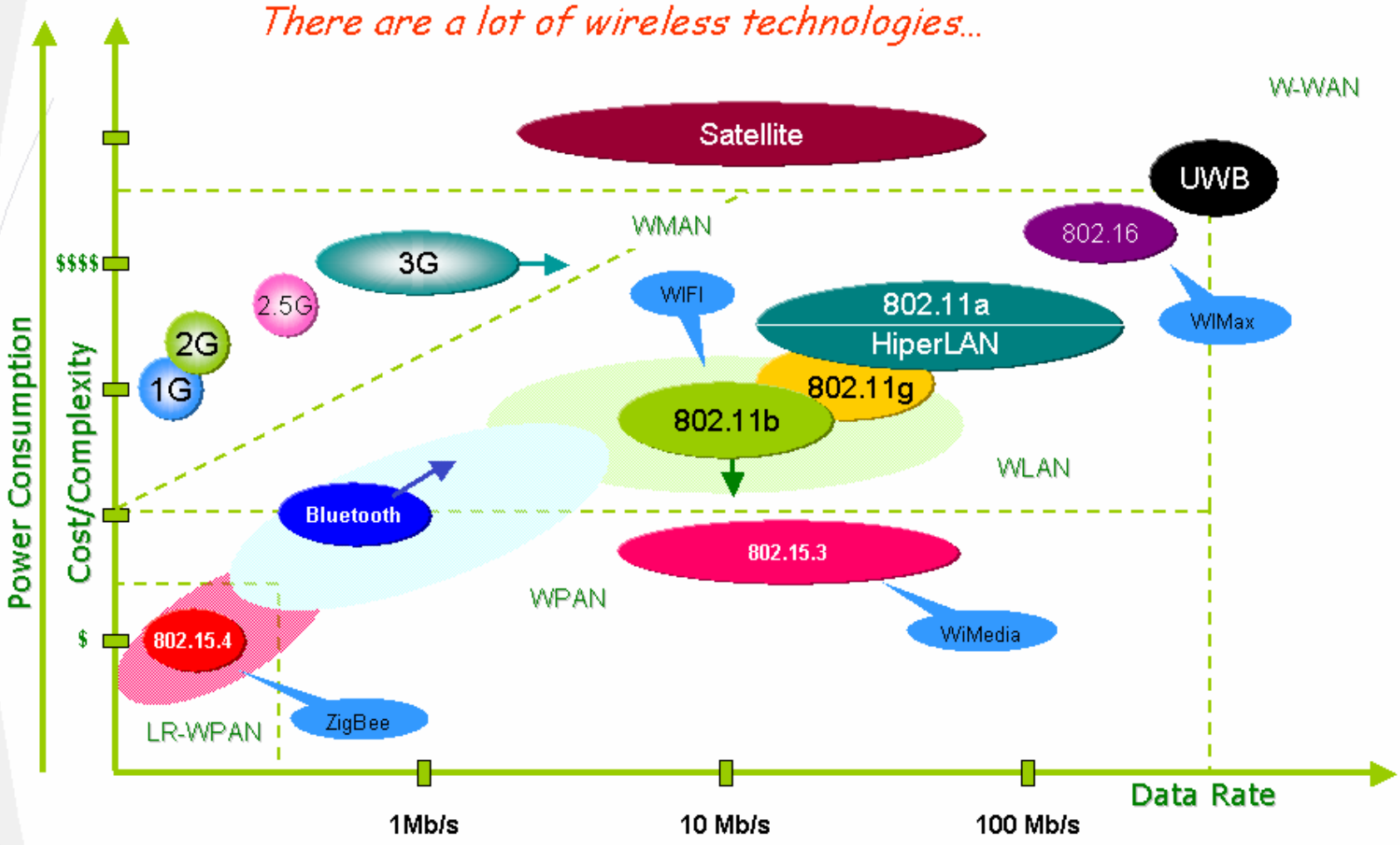
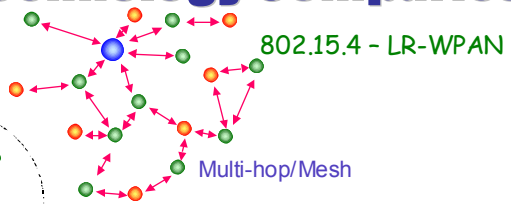
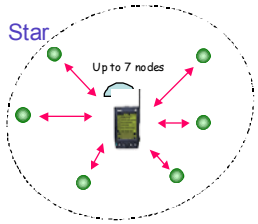
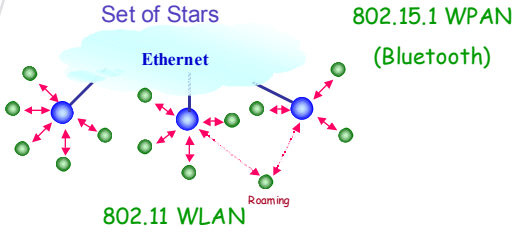
Standard Wireless Technology Map - 2004

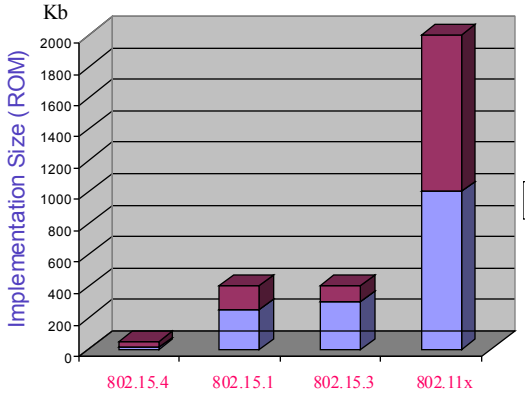


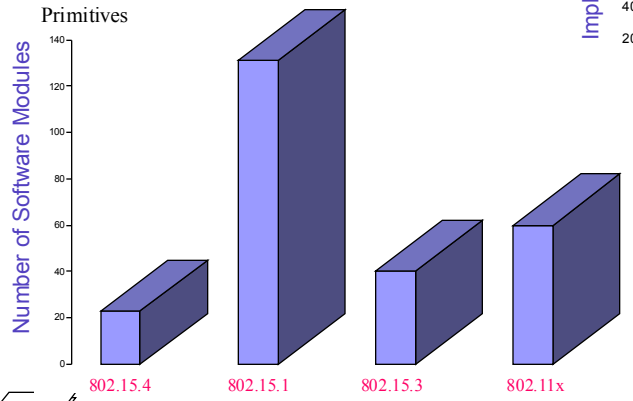
Standard WSN Technology Comparison

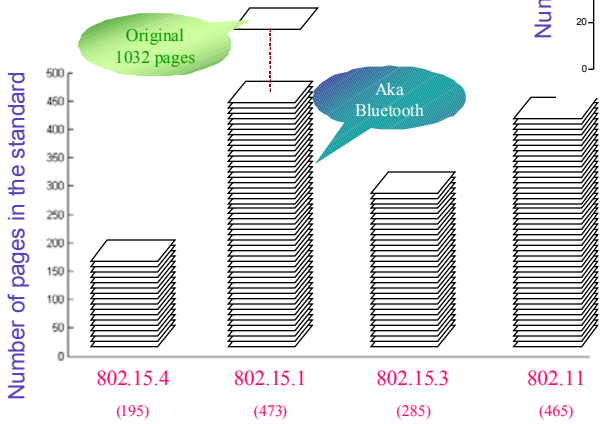












	LR-WPAN	Bluetooth ™	WLAN
Range	~100 m	~100 m	~100 m
Data Throughput	0.25 Mb/s 0.04 Mb/s	1 Mb/s	~2-11 Mb/s
Power Consumption	1	1000	5000
Size	Smallest	Smaller	Larger
Cost	1	10	20

Eaton leads development of standard wireless technologies for the industrial application space

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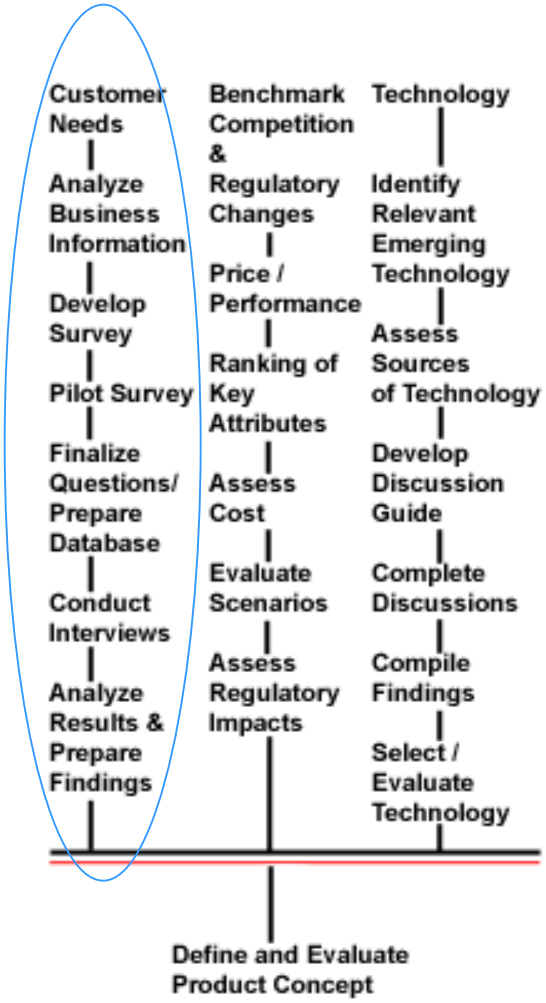
User Requirements

- **Understand and quantify where/how the cost savings occur from a wireless solution**
  - Cost model quantifies opportunities and provides insight into product and network architecture design alternatives
- **Understand customer requirements and constraints**
  - Customer surveys being conducted to gain insight and understanding on how to make the product most useful
  - Determine how to best deploy the wireless approach to compliment existing strategies for condition based monitoring and energy management
- **Understand product requirements to provide a useful solution**
  - Acceptable pricing
  - Optimal network architecture
  - Optimal product form
- **Improve performance and competitiveness of industry**
  - Energy management
  - Productivity

Red Wing Technologies - Market Research Process



Early user involvement supports Eaton's commercialization plan

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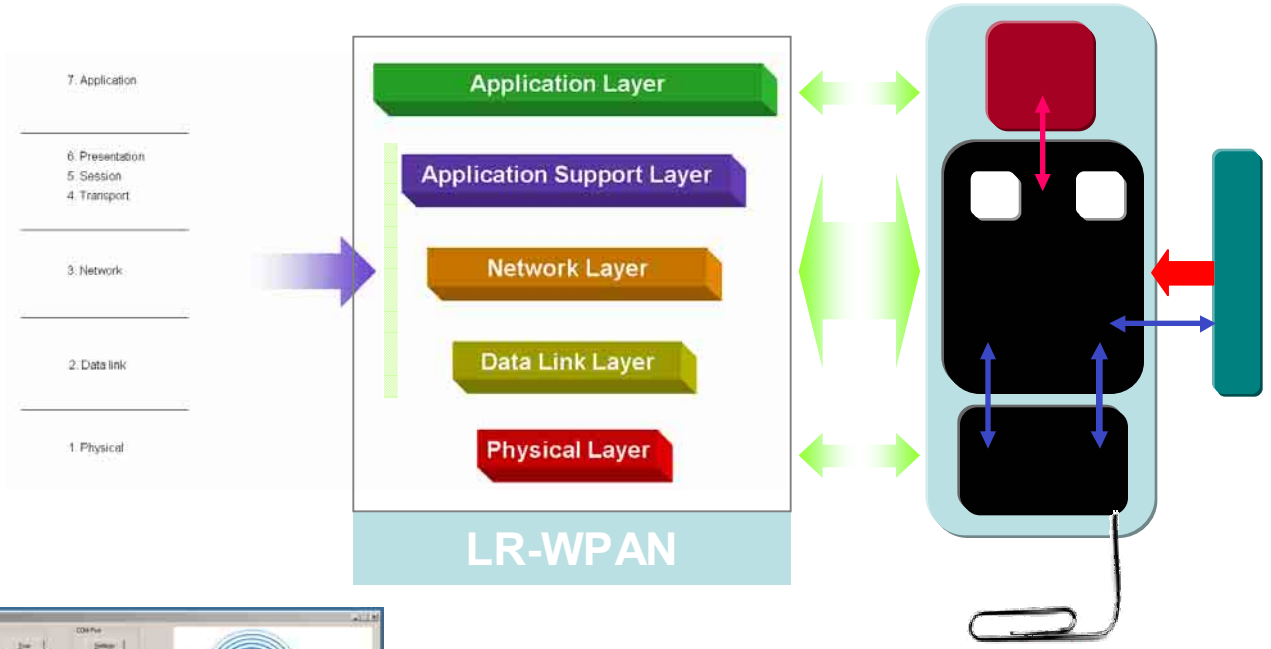
Baseline Wireless Sensor Network



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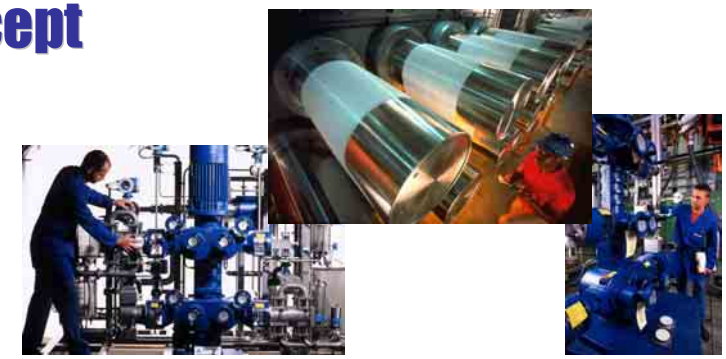
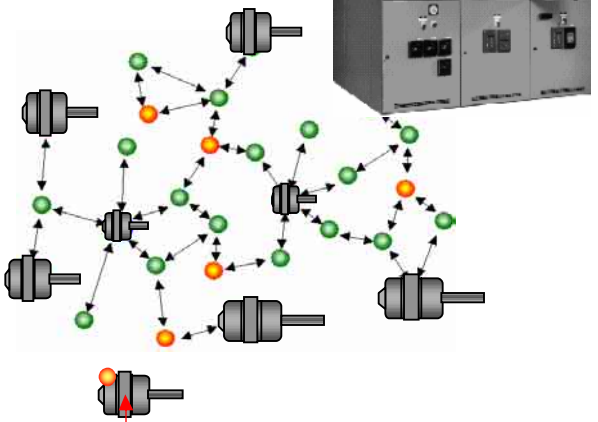
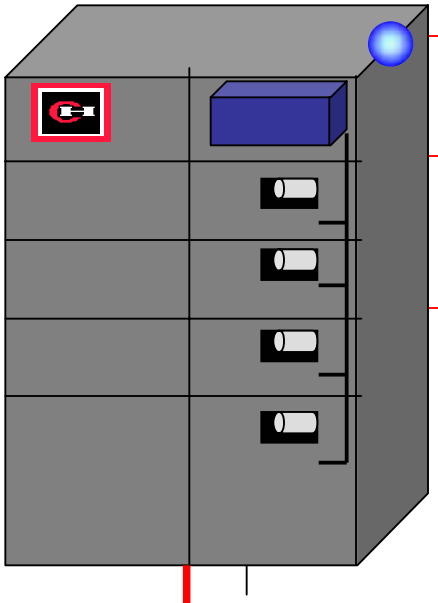
Eaton's Wireless Sensor Network Architectural Concept



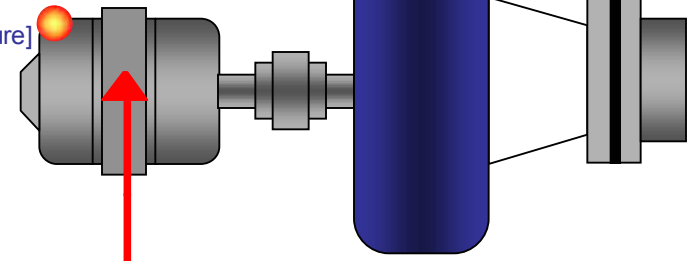




Motor Control Center

Motor

[Temperature]
[RPM]
[Vibration]



Driven Load

3 phase AC power

(no control/signal wires)

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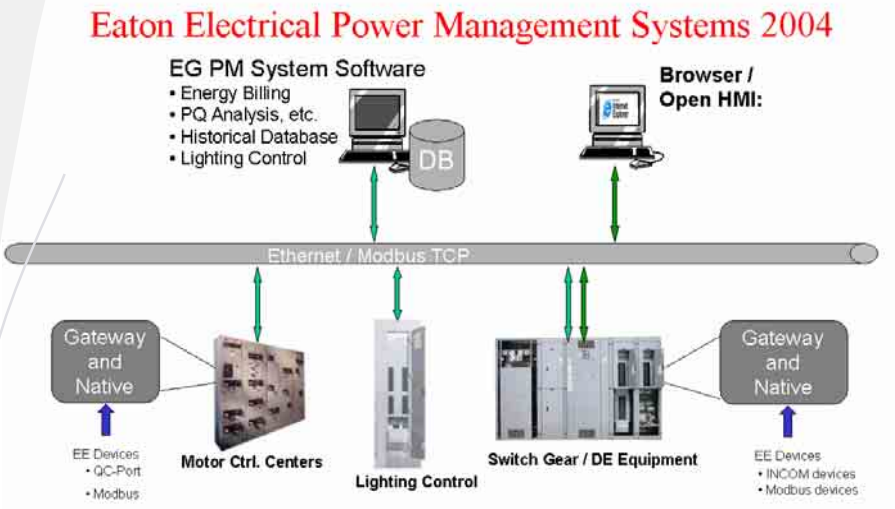
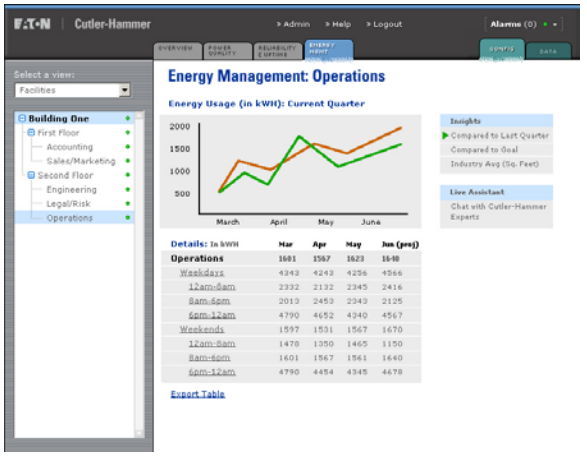
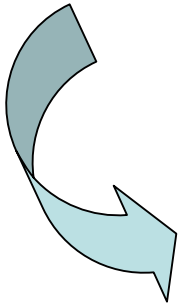
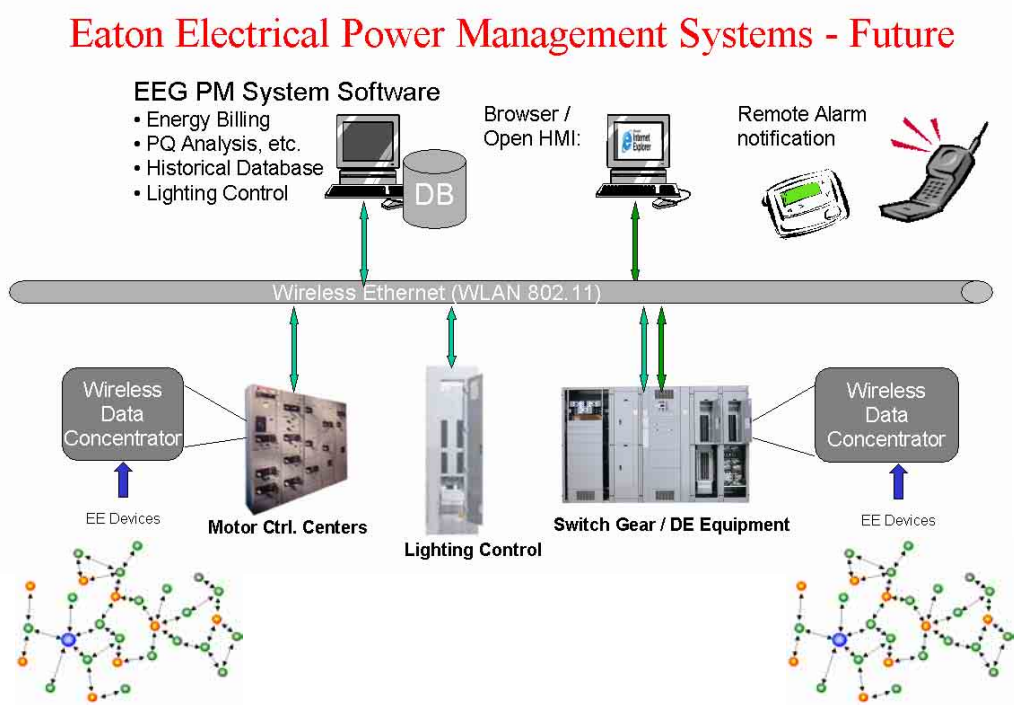
Baseline Wireless Sensor Network

Eaton's Power Management Architectural Concept









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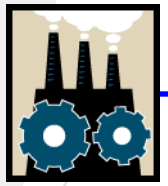
Closing the Loop on Energy Savings



Energy Consumption

Data

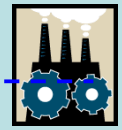
Motor efficiency improvements 4.5%

System efficiency improvements 9.6%

Investment Model

Diagnostics/Prognostics Model

Local Optimization Model



Enterprise Optimization Model

Energy usage data to drive energy savings via capital improvements

Energy and condition sensing data to drive process uptime through diagnostics & prognostics

Energy and condition sensing data to drive local process efficiency improvement

Energy usage data and spot energy pricing to improve enterprise efficiency / costs.

Areas of focus

Eaton's WSN enables continuous energy savings!

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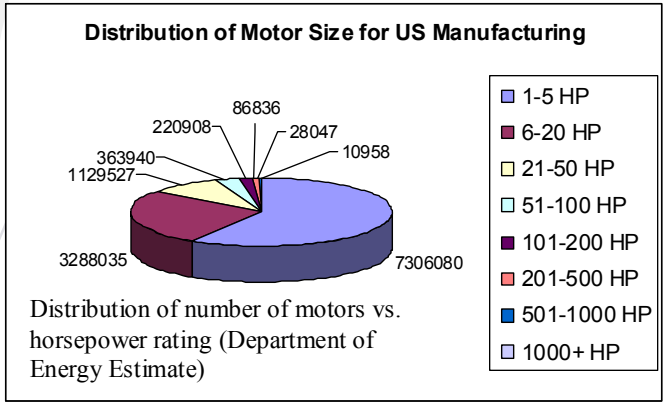
Energy Savings for Industrial Manufacturing Applications



Distribution of number of motors vs. horsepower rating (Department of Energy Estimate)

Electric motor driven process in US

- Accounts for 23% of all US electricity sold
- 98% of motors are <200hp
- Consumes 71% of electrical energy used in industrial process plants

Application of mature technology

- Improving motor rewinding practices
- Reducing system load requirements
- Reducing or controlling motor speed
- Matching component size to load
- Upgrading component efficiency
- Improving maintenance
- Properly sizing motors to applications

Focus Area	Energy saved
Motor efficiency	
• Upgrade motors to meet fed std	2.4%
• Use most efficient motors available	1.2%
• Improved process to rewind motors	0.9%
System efficiency and speed control	
• Correct for motor oversizing	1.2%
• Pump systems	4.9%
• Fan systems	0.8%
• Compressed Air systems	2.7%

Most of these areas can be measured by component level monitoring of the motor only.

WSN removes cost barriers enabling application of proven technology realizing 11% to 18% energy savings in industrial process systems.

United States Industrial Electric Motor Systems Market Opportunities Assessment report, DoE, Dec. 1998

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Eaton's Energy Savings Approach: Conservative Estimates

- Savings related to electrical energy management only.
- Based on 10% energy savings (vs. DOE est. of 11% to 18%).
- Realized savings based on capitalization schedule.
  - Assume 6 to 10 yr motor life
  - 100% R&R by 2020.
- DOE OIT report based data
  - Fuel Consumption tables per industry segment (SIC).
  - Industry segment growth rates.
- Calculation using DOE/ Energetics tool set.

	Energy & Environmental Benefit in 2020								
	Petroleum	**Aluminum**	**Chemical**	**Forest Products**	**Glass**	**Casting**	**Mining**	**Steel**	**2020 Total Impact**
Electrical energy savings (trillion Btu's)	29.8	14.9	78.7	33.5	7.7	4.4	99.0	10.9	279.0
Pollutant Reduction (million lbs)	12.4	6.2	32.7	14.0	3.2	1.8	41.2	4.5	116.1

Assumptions								
% of Market Impacted	100%	100%	100%	100%	100%	100%	100%	100%
Annual Growth Rate	4.8%	-0.8%	2.4%	1.6%	2.7%	-0.8%	6.4%	-0.8%
Year of Product Intro.	2006	2009	2007	2008	2009	2009	2009	2009
Market Penetration Curve	10 Year	10 Year	10 Year	10 Year	10 Year	10 Year	10 Year	10 Year
% Electrical Energy Saving	10%	5%	10%	10%	10%	10%	10%	10%
Yearly Production (x000,000) ton	990	4.6	364.2	88.1	20	14.1	5570	107

Using conservative DOE-based data yields significant electrical energy savings of 279 Trillion Btu's year.

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Online Sensors & Controls Project Evaluation Tool

http://www.energetics.com/sensor_tool/

Inputs based on DOE & other reports

Calculations based on inputs above

Assumptions

User Inputs			
Sector:	Petroleum	% Energy Savings Natural Gas:	0.0%
% of Market Impacted:	100.0%	% Energy Savings Electricity:	10.0%
Annual Growth Rate:	5.0%	% Energy Savings Coal/Coke:	0.0%
Year of Introduction:	2006	% Energy Savings Fuel Oil:	0.0%
Market Penetration Curve:	10 Year Market Saturation	Solid or Liquid Wastes:	0 lbs per tons of product
		Non-Combustion Air Pollutants:	0 lbs per ton of product

Energy Impacts for Petroleum

(Based on the input provided above, this technology will have the following impacts:)

	2005	2010	2015	2020
MARKET PENETRATION	N/A	21.1%	70.7%	95.6%
MARKET (Million tons)	N/A	340	1,455	2,511
ENERGY SAVINGS				
Natural Gas Energy Savings (trillion Btu)	N/A	0.000	0.000	0.000
Electricity Savings (trillion Btu)	N/A	4.049	17.316	29.883
Coal Energy Savings (trillion Btu)	N/A	0.000	0.000	0.000
Fuel Oil Energy Savings (trillion Btu)	N/A	0.000	0.000	0.000
TOTAL ENERGY SAVINGS	N/A	4.049	17.316	29.883
POLLUTANT REDUCTIONS (lbs)				
Carbon (MMTCE/yr)	N/A	0.07693	0.32900	0.56778
Nitrogen Oxides (NOX)	N/A	1,433,378	6,129,772	10,578,627
Sulfur Oxides (SOX)	N/A			
Carbon Monoxide (CO)	N/A	190,307	813,840	1,404,507
Volatile Organic Compounds (VOCS)	N/A	20,245	86,579	149,416
Particulates	N/A	40,491	173,157	298,831
Other (million lbs)	N/A	0	0	0

User Explanations	
Technology Description:	Develop a wireless network for DOE's IoF
Market Percentage:	6 to 10 year life on 0 to 200 HP motors, upgrade to energy management when R&R
Introduction Year:	Beta test in 2 years, product intro 1 year after beta
Energy Impacts Percentages:	the major impact will be on electrical. Not sure how to include wellness in this calculation
Other Wastes and Pollutants:	Possible reduction of non-combustion pollutants on restart.

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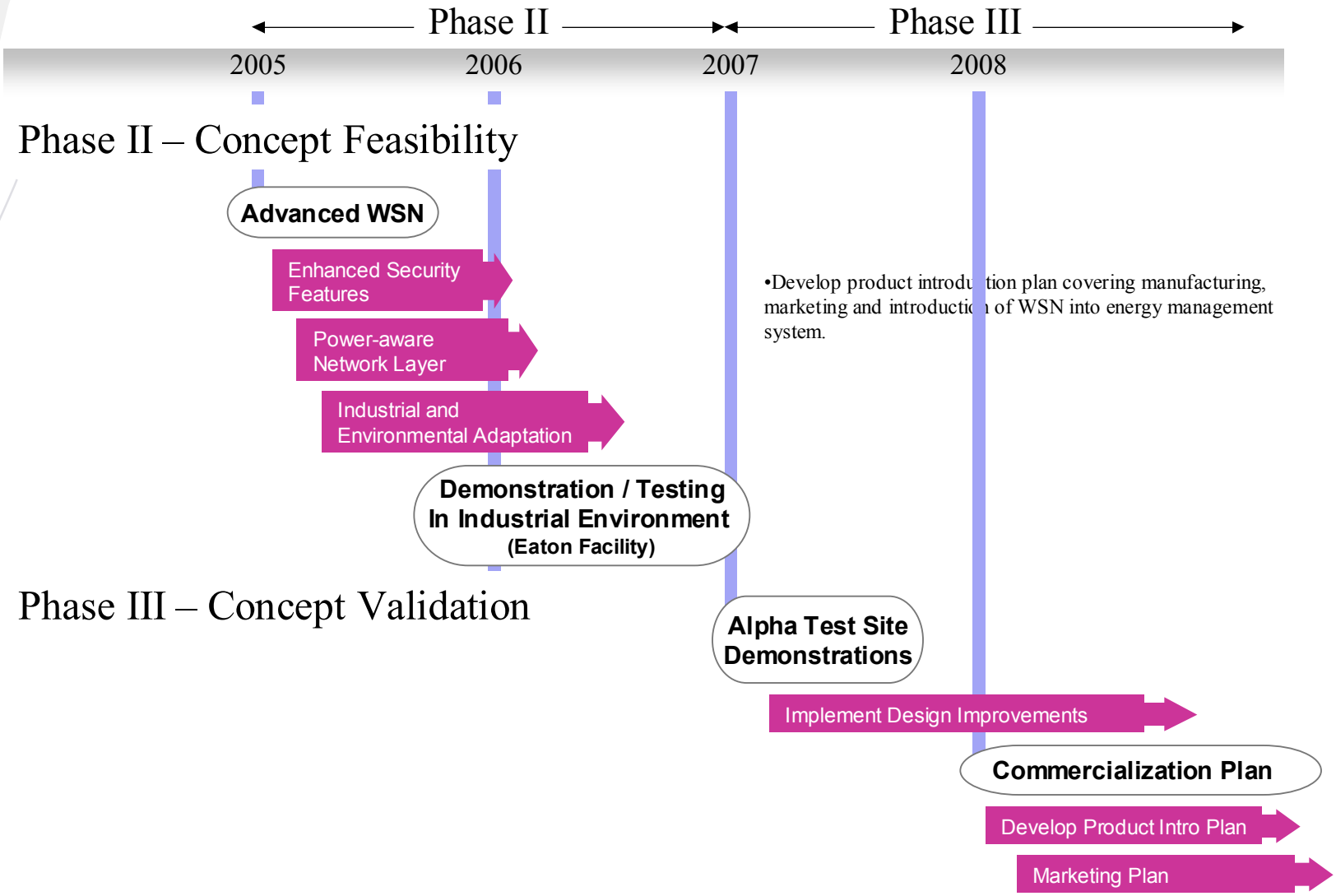
Future Plan



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Concluding Remarks

Eaton's WSN strategy will yield an 11% to 18% energy reduction in industrial motor energy consumption by 2020.

Eaton understands the technical aspects and the economics of the problem. 80% cost reduction vs. wired sensors proven by our costing tool .

Eaton's understanding of the needs of the end user community is based on a thorough customer needs definition process.

Eaton understands wireless technology and are thought leaders within industry and standards organizations through IEEE802, IEEE1451, WINA and the ZigBee Alliance

Eaton has business units serving IoF well positioned to bring products to market.

Industrial Wireless Sensor Network

PAN Coordinator Type MA

Technical Data

Nutrition Facts

Serving Size 1 Wireless Industrial Network

Amount Per Serving

Calories 0

		% Daily Value*
Total RAM	**Minimal**	**100%**
Total ROM		**100%**
Simplicity		**100%**

*** Percent value is based on actual implementation using Model Based Protocol Stack design techniques**

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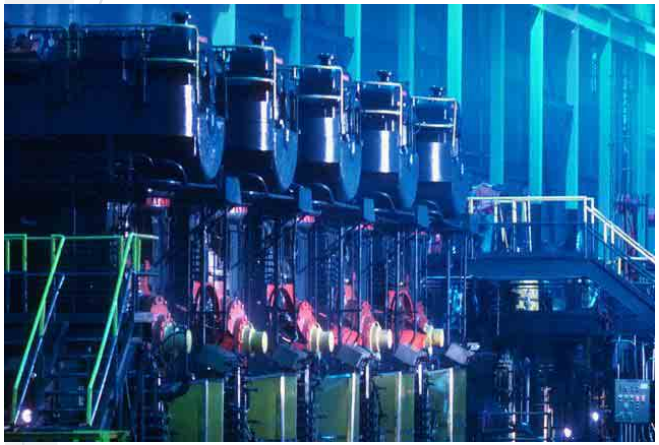

Thanks!

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